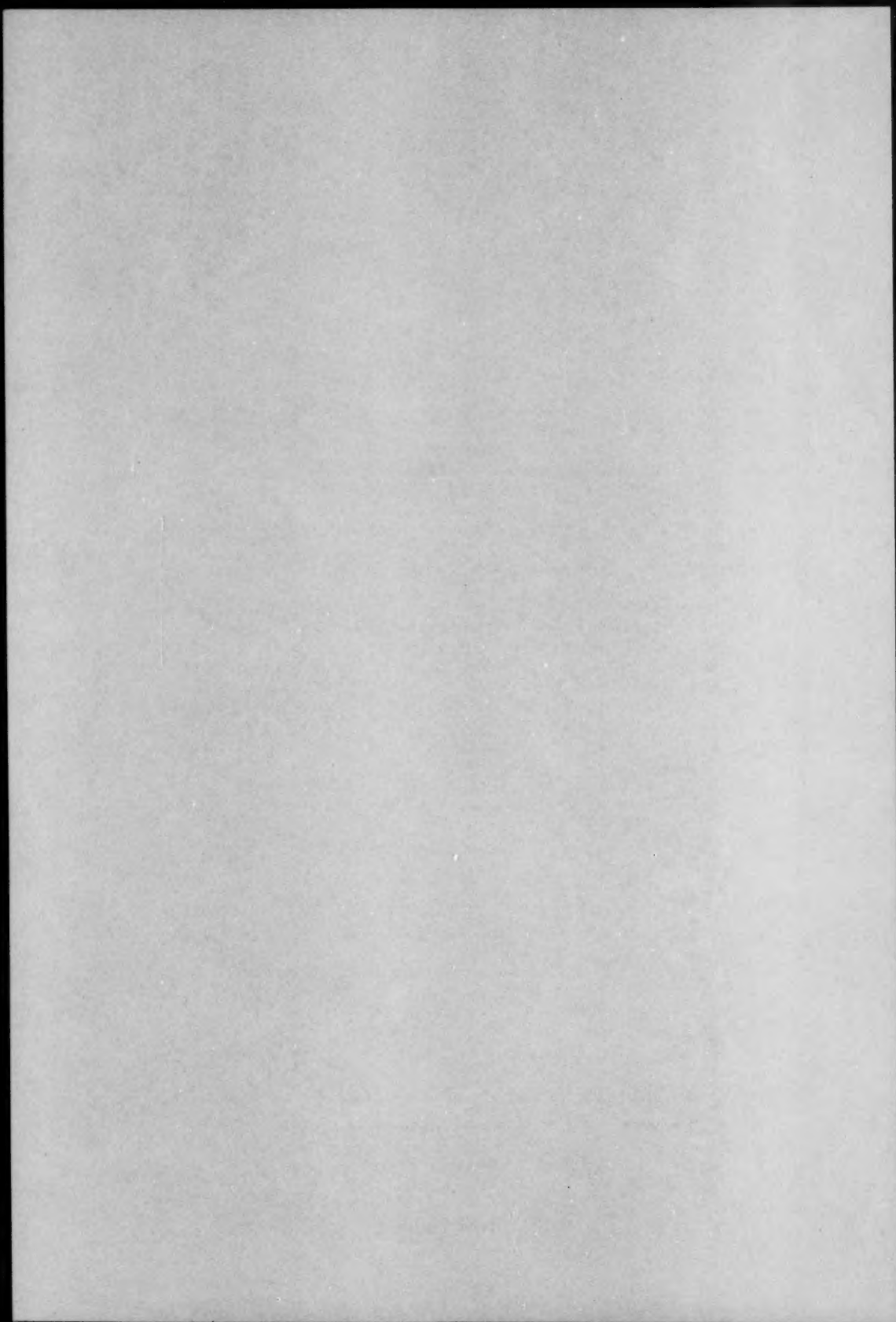


# ACTA POLYTECHNICA SCANDINAVICA

ANNOTATED INDEX 1989–1991

HELSINKI 1992



# ACTA POLYTECHNICA SCANDINAVICA

## Annotated Index 1989-1991

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Ch 188

PARTANEN, J., **Mean Activity Coefficients of Several Uni-Univalent Electrolytes in Dilute Aqueous Solutions at 298.15 K.** Helsinki 1989, 89 pp. ISBN 951-666-277-3. UDC 541.183.2:66.021.3

Keywords: Activity, hydrochloric acid, hydrobromic acid, hydriodic acid, potassium chloride, sodium chloride, lithium chloride, potassium bromide, ammonium chloride, dilute aqueous solutions, transference number, critical evaluation.

Activity coefficients of HCl, HBr, HI, KCl, NaCl, LiCl, KBr and NH<sub>4</sub>Cl in aqueous solutions can be calculated up to the molalities of about 0.1 mol kg<sup>-1</sup> within experimental error from the Hückel equations obtained in this study. These equations were estimated as reliably as possible from the results of galvanic cells with or without liquid junction. All experimental data used in the calculations were taken from literature. The Hückel equations were tested with appropriate cryoscopic and isopiestic sets in addition to with electrochemical sets. The activity coefficients of the Hückel equations were compared with those of the equations of Hamer and Wu (1972) and of Pitzer and Mayorga (1973). Mostly the consistency between the activity coefficients of the three origins is satisfactory but in the case of some electrolytes the Hückel equation gives clearly different activity coefficients from the values of either Hamer's or Pitzer's equation.

Ch 189

MÄNTYSALO, E., **Fur Testing Methods: Results for Mink.** Helsinki 1989, 24 pp. ISBN 951-666-284-6. UDC 675.6.026:006.1

Keywords: Fur, chemical testing, physical testing, quality control, tanning.

In addition to the well known phenomenological classification used in the international fur trade, tensile strength, tearing strength, elongation properties, flexing endurance, adhesion of hair, wear resistance of hair coat, and stability of fur against weather or light form the basic data set of physical testing methods in the characterization of skin or leather of fur. The most important chemical testing methods are concerned with the measurement of pH value, shrinkage temperature, concentration of fixed tannin, quality and amount of oil or fat and other constituents used to produce the leatherlike appearance. Restricted to mink fur, methods, data and suggested acceptance limits are given in this work for the discussion of acceptable quality of processed furs.

Ch 190

NKONDE, G.K., **Analysis of Selective Recycle Systems.** Helsinki 1989, 23 pp. ISBN 951-666-286-2. UDC 66.022:519.21:51.001.57

Keywords: Selective recycle, gamma distribution, general distribution.

This thesis is based on five different publications based on a theoretical study of a recycle system with selective recycling. Different mathematical models of the system have been developed. These models have been used to analyse and simulate both theoretical and experimental residence time distribution (RTD) for different mixing flows in reactors.

Methods are presented for calculating the number of cycles distribution (NCD) from a given residence time distribution. A general distribution and a discrete gamma distribution for the NCD are presented. Mathematical models showing the relationship between the NCD, RTD, and total regional residence time distribution (TRRTD) are presented in terms of the covariances and correlation coefficients of these variables. The joint distributions of the NCD, RTD and TRRTD using a discrete gamma distribution are given. Graphical and mathematical models of the series equivalent to a recycle system with selective recycling are also presented. Conversion in a reactor has been calculated from the number of cycles distribution and residence time distribution using the concept of selective recycling.

The study shows that, given the RTD of a system, the NCD can be obtained by matching its RTD moments to the RTD moments of a selective recycle system. The numerically calculated NCD is then used to simulate the given RTD. The general distribution for the NCD is a new and convenient distribution for analysing selective recycle systems. For first and zero order reactions, whose RTD is known, the NCD and the conversion for the reaction is readily obtained using the concept of selective recycling.

Ch 191

MOJTAHEDI, W. and GLASS, D.H., **Effect of Solids Circulation on Bubble Parameters in a Freely-Bubbling Fluidized Bed**. Helsinki 1989, 55 pp. ISBN 951-666-295-1. UDC 662.96:66.074:661.7

Keywords: Gas fluidized bed, bubbling properties, size distribution.

Bubbling properties of a three-dimensional, freely-bubbling gas fluidized bed was investigated at normal pressure and some of the findings are reported in this publication. Bubble rise velocity, bubble size and spatial distributions are measured in the presence and the absence of a tube-bundle. Two different gas distributors are employed and the results are compared under identical fluidising conditions. A gamma-function size distribution correlation is derived which fits the experimental data remarkably well. This was fitted to enable a comparison of the measured data with theoretically predicted values and also to enable extrapolation of size distributions into the region where experimental size measurement was not possible (i.e. very small bubbles). An attempt was made to study the characteristics of the particulate phase circulation patterns which exist in gas fluidized beds, using the experimental results obtained.

Ch 192

KAUTOLA, H., **Biotechnical Production of Itaconic Acid by Immobilized Aspergillus terreus**. Helsinki 1989, 36 pp. ISBN 951-666-296-X. UDC 579.66

Keywords: Itaconic acid, immobilization of fungi, Aspergillus terreus.

The biotechnical production of itaconic acid with immobilized biocatalysts was optimized and compared with that obtained with the free mycelium. Microorganisms *Aspergillus terreus*, TTK 200-5-1, G-026, TTK 200-5-3 or TTK 200-5-2 were employed as biocatalysts. The carriers used were polyurethane foam or gel, polyacrylamide, agar or alginate gel, celite or nylon matrix. The bioreactor systems investigated were shake flasks or single-stage columns sized between 14 ml and 14 litres either as packed bed or airlift reactors and 3-stage 220 ml airlift column systems. Glucose, sucrose and xylose were used as the carbon source in repeated batch or continuous fermentations in different conditions. Both polyurethane foam

and celite turned out to be good carriers for itaconic acid production. Immobilization increased itaconic acid production about 2-fold. A decrease in the carrier size increased productivity. The process with the immobilized biocatalyst was very stable with no decrease in activity in repeated batch fermentations up to 14 months and in continuous production at least for 4.5 months. It was shown that the immobilized biocatalysts were quite suitable for biotechnical production of itaconic acid, also in a large scale with liquid volume of 9 litres in a 14 litre bioreactor. In this work actual comparable yields and volumetric productivities of itaconic acid produced with immobilized mycelium could be calculated. It was proved that itaconic acid could be produced with immobilized biocatalysts also from pentoses which are known as poor substrates in biotechnical biomass utilization.

Ch 193

HEPOLA, J., **Desulphurization by Limestone Injection at High Temperature**. Helsinki 1990, 41 pp. ISBN 951-666-297-8. UDC 662.96:66.074:661.2

Keywords: Desulphurization, limestone injection.

An isothermal flow reactor was used to characterize physical and chemical processes during calcination and sulphation of limestones. The experimental data from the flow reactor were compared to a calcination model, which assumed that calcination was proportional to the specific surface area (BET) of undecomposed calcium carbonate, and to two sulphation models; a random pore model and a grain model in the case of product layer diffusion control.

The results indicate that the limestones undergo significant physical changes during the calcination process. The calcium carbonates calcined in less than 0.3 second under typical combustion conditions. The calcination results were quite well predicted up to 80 % conversion with the calcination model used.

The results of the sulphation and the simultaneous calcination and sulphation suggest that under conditions typical of sorbent injection in the boiler, the major portion of the calcium sulphate formation will occur very rapidly (during about 0.3 s). The electron microprobe analyses showed that the sulphur seemed to be mainly on the outer surface of the reacted particles. The sulphation data obtained in this study are in agreement with the assumption presented earlier by many investigators that the main limiting step of sulphation for small particles at high temperature is product layer diffusion which occurs by solid state mechanism.

Ch 194

WAHLGREN, M., SIVIK, B. and NYSTRÖM, M., **Dextran Modifications of Polysulfone UF-Membranes: Streaming Potential and BSA Fouling Characteristics**. Helsinki 1990, 18 pp. ISBN 951-666-298-6. UDC 66.067,541.18.045.2,547.962.3,541.183.02,543.5

Keywords: Fouling, proteins, modification, dextrans, UF membranes, zeta potential measurements.

Polysulfone ultrafiltration membranes were modified with dextran, dextran sulfate and DEAE-dextran. The behaviour of the modified membranes towards static adsorption of bovine serum albumin (BSA) was investigated in the pH range 3-7. The modified membranes showed lower flux losses after protein adsorption than unmodified membranes. The plain dextran was considered to be the best choice of the three as a modifying agent. Streaming potentials were measured for the DEAE dextran and dextran T500 modified membranes as a

function of pH. The isoelectric points of the membranes were 5.9 and 4.6, respectively. Titration data for DEAE and dextran T500 are also presented.

The modification of membranes with dextrans of different molecular weight average indicated that the shorter dextran molecules (Dextran T10) gave a better result than the larger ones (Dextran T500).

Ch 195

NIINISTÖ, L. (ed), **1st International Symposium on Atomic Layer Epitaxy**. Helsinki 1990, 209 + VI pp. ISBN 951-666-309-5. UDC 539.23:541.17:621.315.59

This volume contains the proceedings of the 1st International Symposium on Atomic Layer Epitaxy held June 11 - 13, 1990, in Espoo, Finland.

Ch 196

MASUKU, C., **Thermal Reactions of the C-O and Alkyl C-C Bonds in Lignin Model Compounds**. Helsinki 1991, 27 pp. ISBN 951-666-326-5. UDC 66.092:66-974:547.992.3

Keywords: Carbon-oxygen bond cleavage, carbon-carbon bond cleavage, lignin model compound, methoxyl group, thermal reaction pathway, thermolysis.

Four monomeric and one dimeric lignin model compounds representing the aromatic methoxyl, p-hydroxycinnamyl, syringyl, propylguaiacyl and phenylcoumaran structures were thermolyzed at temperatures of 598-673 K under an inert atmosphere, in order to identify the thermal reaction pathways that initially occur in thermochemical conversion of lignin. The main reaction pathway is the cleavage of the alkyl C-O bond. In addition, the cleavage of the arylalkyl C-O bond, alkyl C-C bonds and a methylation reaction occur either concurrently with or consecutively to this main reaction pathway. The cleavage of the aromatic C-O bond of the methoxyl group is more common than the cleavage of the phenolic C-O bond. The cleavage of the alkyl C -C bond in a carbon chain is the most favoured. The bond cleavage reactions are strongly affected by reaction temperature and reaction time. The mechanism for the cleavage of the alkyl C-O bond is most likely an aggregate of the free radical, pericyclic and hydrolysis reactions, at least for those compounds with an ortho-oxygen substituent group.

Thermal reaction pathway schemes have been developed for the different model compounds. In the thermolysis of 4-propylguaiacol, the main reaction leads to the formation of 4-propylpyrocatechol. In the thermolysis of dihydrodehydrodiisoeugenol, the cleavage of the alkyl C-O bond occurs in the dihydrofuran ring prior to that in the methyl ethers, to form open chain dimers. The other reactions occur in the open chain dimers and in the monomer products to form smaller molecular mass products. In the thermolysis of methylanisoles and dimethoxyphenols, the cleavage of the alkyl C-O bond leads to the formation of the corresponding cresols and dihydroxyanisoles, respectively. The meta substituted compounds give the highest amount of nuclear methylated products. In the thermolysis of alkylphenols, the main reaction is the cleavage of the alkyl C-C bond to form smaller molecular mass phenols. The longer the carbon chain, the more reactive the alkylphenol.



Ch 197

BJÖRNBOM, E. et al., **Reduction of  $\text{NO}_x$  with  $\text{NH}_3$  in Presence of Pyrolysed Macro-Cycle Catalyst.** Helsinki 1991, 14 pp. ISBN 951-666-331-1. UDC 542.941:502.36

Keywords: Nitrogen oxides reduction, ammonia, catalytic, active carbon, porphyrin.

Reduction of  $\text{NO}_x$  with  $\text{NH}_3$  in presence of pyrolysed cobalt-tetra-phenylporphyrin, CoTPP "macro-cycle black", was studied. Active carbon, Norit RBXS 1, was used as a carrier. The experimental conditions were varied as follows: temperature from 95 to 140°C, space velocity of the gas mixture 1000-5000  $\text{h}^{-1}$  and catalyst content 0-1 %.

The results showed that, in the experimental range studied, the temperature has no significant effect on the conversion of  $\text{NO}_x$ . The conversion of  $\text{NO}_x$  at low space velocity of the gas (1000  $\text{h}^{-1}$ ) was high (approx. 90 %), both in the presence and in the absence of CoTPP black. This was explained by the fact that the active carbon used as a catalyst support also has a catalytic effect on the reduction of  $\text{NO}_x$ . At low space velocity this effect is sufficient to achieve high conversion of  $\text{NO}_x$  in presence of active carbon only. The conversion decreased at higher space velocity, however. The presence of CoTPP black counteracted the negative effect of the increased space velocity. The effect of the "macrocycle black" on the conversion of  $\text{NO}_x$  was significant at higher space velocities.

Ch 198

SEPPÄLÄ, J., LINKO, Y. and SU, T., **Photo- and Biodegradation of High Volume Thermoplastics.** Helsinki 1991, 33 pp. ISBN 951-666-333-8. UDC 678.073:620.193.6:620.193.8

Keywords: Photodegradation, biodegradation, polyethylene, polypropylene, polyvinyl chloride, polystyrene, thermoplastics, waste disposal.

This review briefly covers the basic considerations of plastic waste disposal, basic principles of photo- and biodegradation of the high volume thermoplastics, and characteristics of each of polyethylene, polypropylene, polyvinyl chloride and polystyrene in their photo- and biodegradation. Starch as a biodegradable filler in such plastics is also discussed.

Ch 199

BULSARI, A., MEDVEDEV, A. and SAXÉN, H., **Sensor Fault Detection Using State Vector Estimator and Feed-forward Neural Networks Applied to a Simulated Biochemical Process.** Helsinki 1991, 20 pp. ISBN 951-666-337-0.

Keywords: Artificial neural networks, sensor fault detection, state vector estimation, biochemical process.

The aim of this work was to investigate the combination of two recently developed techniques to detect sensor faults in dynamic systems, exemplified by an application to an industrially important biochemical process of *Saccharomyces cerevisiae* growing on a substrate of glucose, releasing ethanol as a product of primary energy metabolism.

The first part of the sensor fault detection procedure is the state vector estimation based on delayed measurements of the control and output vectors, a method developed recently. The state vector estimator is based on linear dynamics and incorporates a priori information regarding system dynamics. Observer residuals are calculated as the difference between two estimations of the plant state vector, one including the last measurement data, and one excluding the last measurement data. These residuals are fed to a feed-forward neural

network, which is trained to recognize which particular sensor(s) is/are faulty.

The Levenberg-Marquardt method was used to train the networks by error square sum minimization. The method is known to be fast, accurate and reliable.

The trained neural networks successfully identified single and multiple faults during the testing phase, when they were fed with data which they were not trained on.

Ch 200

**OLGUN, Ö., A Study of the Kinetics of the Hydrogenation of Cottonseed Oil in a Semi-Batch Slurry Reactor.** Helsinki 1991, 22 pp. ISBN 951-666-338-9.

**Keywords:** Hydrogenation of vegetable oils, cottonseed oil, kinetics of hydrogenation.

The kinetics of the hydrogenation of cottonseed oil at different operating conditions were investigated in a semi-batch slurry reactor. The experimental results were used in the proposed reaction mechanism model to calculate the reaction rate constants. These specific rate constants were used for comparison in choosing the most selective set of operating conditions.

Ci 92

GERO, J.S. and OKSALA, T. (eds), **Knowledge-Based Systems in Architecture**. Helsinki 1989, 143 pp. ISBN 951-666-278-1. UDC 72.01:681.3

**Keywords:** Knowledge-based systems, architectural design, computer-aided design, models of design, creativity.

Selected and edited versions of papers presented at TIPS'88 Conference held in Otaniemi, 15-16 August, 1988, are published here. The thirteen papers cover a broad range of knowledge-based ideas from an architectural perspective. Considerable attention is devoted to conceptual models and their place and role in knowledge-based systems. In particular, the articulation of conceptual models appears to offer an important foundation for knowledge-based systems. Including a much broader range of information and even knowledge in the database of a CAD system is the goal of the work described in a number of papers. Finally, that most significant of design characteristics - creativity - is considered from various viewpoints within the context of knowledge-based systems.

Ci 93

TUOMINEN, P., **Generation of an Axisymmetric Cylindrical Shell Element Using a Shooting Method**. Helsinki 1989, 50 pp. ISBN 951-666-287-0. UDC 624.074.4:519.62/65

**Keywords:** Axially symmetric, cylindrical shell, shooting method, error contours, finite element method.

This article is part of a larger study dealing with the use of the finite difference method in connection with the finite element method. A finite difference shooting method is considered. The method is used to generate axisymmetric shell finite elements.

The method is first described generally in connection with axially symmetric this surface elements. Secondly a cylindrical shell element is formed. Properties of the method are considered using numerical examples. Results are compared with analytical ones. Some conclusions concerning the use of the method are drawn. A brief consideration of the differences in results obtained by approximate and complete Flügge equations for a cylindrical shell is made.

Ci 94

PAAVOLA, J., **A Study of Curved Thin-Walled Girders**. Helsinki 1990, 91 pp. ISBN 951-666-299-4. UDC 624.072.2:624.27:519.62/64

**Keywords:** Thin-walled girders, box beams, finite element method.

The numerical model for analysing thin-walled girders is developed. The linear elastic material model and the theory of infinitesimal displacements and strains are adopted. The method is based on a further development of the conventional idea for torsion of thin-walled girders with a closed cross-section presented by Vlasov and is combined with the finite element method. Economical aspects often support developing these kinds of coalitions, taking into account the special nature and properties of structures of this type, to reduce the size of the computational model required.

The displacement approximation is spanned at certain cross-section planes between which the interpolation is performed. This procedure permits the application of the method in which the lateral displacement state is chosen, in advance. Attention is paid to an algorithm to create a basis system for the displacement state of a general, arbitrary shaped cross-section, consisting of piecewise rectilinear cross-sections of separate shells. The effects of torsion, distortion, torsional and distortional warping as well as shear deformations can be included in the analysis through this creation of the displacement state. The expressions for strains are derived in a local orthogonal coordinate system to avoid too complicated formulae due to curvilinear coordinates. In numerical examples the cross-sections of the girders analysed have been of varying shape or wall thickness, the girders have been straight or curved having perpendicular or skew support lines. The cross-sections have also been of open or closed composition.

The numerical comparisons performed reveal throughout a good agreement between the results of the present method and experimental and numerical data found in the literature. Especially, a very good conformity with numerical thin shell solutions can be observed.

Ci 95

**VUOLIO, R., Blast Vibration: Threshold Values and Vibration Control.** Helsinki 1990, 146 pp. ISBN 951-666-301-X. UDC 622.235:699.84:534.83

**Keywords:** Blast, vibration, threshold values, vibration control, peak particle velocity, scaled distance, cooperating charge, charge per delay, charge per blast, blast damage.

Over the past 30 years, the Nordic countries have developed similar practices for estimating damage caused by rock blasting vibrations. However, over the last few years the risk of damage has sometimes been estimated by using international values, which have created unnecessary costs, since they are too conservative.

This paper gives a proposal for Finnish blast vibration standards and a calculation model for the extent of the zones for building inspection, risk analysis, and vibration measurements. The international conclusion is that particle velocity is the best description for limiting damage potential for structures. The data collected for this paper during 1970-1989 shows that the most practical description is the vertical component of the peak velocity. As rock is a nonhomogenous medium, it is hard to predict the need and scope of risk analyses, building inspection, and vibration measurements. As a large number of blasts was monitored for the recording of the peak particle velocity in several locations in Finland, and the data was combined, it is possible to establish safe scaled distances for the calculation of the need and scope of risk analyses, building inspection, and vibration measurements.

Ci 96

**HEIKKILÄ, P., Improving the Quality of Crushed Rock Aggregate.** Helsinki 1991, 169 pp. ISBN 951-666-327-3. UDC 622.732:622.733:622.235:625.072

**Keywords:** Rock, aggregate, crushing, blasting, quality, strength, shape.

This research work is an analysis of the results obtained in the research project "The Effect of Blasting and Crushing Practice on the Quality of Pavement Aggregate" which was a subproject of an extensive research programme to improve the quality of asphalt pavements in Finland (ASTO-programme).

The goal of the project was to draft recommendations for blasting and crushing in

aggregate production.

During the research period 1987-1990 full-scale blasting and crushing tests were conducted at seven crushing plants to test various ways of improving the quality of the aggregate. These included the application of careful blasting practice, sieving low-quality products aside either prior to primary crushing or after the first crushing stages and improving the quality of the final product by after-treating it with an impact crusher or a sieve with rectangular openings.

According to the results of both the field tests and a literature survey the best way to improve the quality of crushed rock aggregate is to sieve aside the structurally damaged and badly-shaped final product size fraction produced by blasting and the first crushing stages. When top-quality aggregate is required, only the product of the last crushing stage should be utilized.

The first part of this preliminary recommendation was successfully tested in production scale at two quarries.

EI 64

SINKKONEN, J. (ed), **Treatise on Microelectronics**. Helsinki 1989, 403 + IX pp. ISBN 951-666-281-1. UDC 621.38:621.315.59:061.3

This volume contains a collection of invited papers on the Finnish microelectronics and the proceedings of the Advanced Summer School on Microelectronics: Future Trends in Solid State Electronics, June 5 - 8, 1989, Espoo, Finland.

EI 65

NIIRANEN, J., **Operation of Inverter Equipment with a DC Supply Containing Low Frequency Ripple - An Analysis of Input Impedance**. Helsinki 1989, 123 pp. ISBN 951-666-289-7. UDC 621.314.26:621.337:621.391.82:629.066

Keywords: Invertors, pulse width modulation, induction motors, traction, electromagnetic interference, signalling, electric impedance.

Inverted-fed cage induction motor traction drives are gaining popularity in all kinds of vehicles. However, the possibility of interference with the existing signalling equipment is an often encountered question. One aspect in this field is the impedance of the drive, which for its part determines harmonic current levels caused by the supply station dc voltage ripple. In this thesis the expressions for the impedance are derived and a comparison with the measurements is made. Means of increasing the impedance level are presented. Especially frequency modulation (FM) of the inverter frequency is examined. Frequency modulation is shown to prevent the rectification of low frequency ripple components in the inverter, which cause subharmonics in the motor current. It turned out that frequency modulation does not increase the impedance level much. However, considerable savings can be achieved in vehicles fed by a single phase ac supply, because in most cases the heavy second harmonic filter can be omitted.

EI 66

ALAHUHTA, M., **Global Growth Strategies for High Technology Challengers**. Helsinki 1990, 144 pp. ISBN 951-666-311-7. UDC 65.012.4

Keywords: Global growth strategies, global management, high technology.

Research on global strategies has so far concentrated mainly on big multinationals. The current market trends leading toward greater global uniformity in several industries bring attractive opportunities for these companies. Only little literature exists on global strategies for small and medium-size companies. The purpose of this research was to identify strategy patterns for global growth of high technology challengers.

The research was carried out based on multiple-case study research methodology. Six high technology challengers, which during the period 1982 to 1989 had global growth significantly exceeding market growth, were studied in depth. Additional insight was gained by looking at two other challengers.

The results show that strategy patterns for global growth are different for fast growing high technology challengers in high growth - rapid change industries and in maturing - slow change



industries, although also several similarities exist. In the former case, the fast global growth of a company is triggered by exploiting a product-related industry shift. In order to manage such an opportunity, these challengers set early global objectives, enter lead markets early to be aware of technology trends and changes in customer requirements, and they quickly develop a leading quality global product, with their strong, internal R&D. By correctly timing a leading quality global product, these challengers achieve quick volume growth through OEM partnerships and other distribution channels. In order to sustain their strategy, these challengers build selective, functional foreign investments looking for comparative advantage, closely spaced in time. They manage their functional, global networks in an interdependent way. These challengers continuously develop product quality and introduce new product models. Moreover, the start-up challengers carefully expand product scope within their business definition to build bases for further growth.

Similarly, the challengers in maturing - slow change industries set clear global objectives and enter lead markets early. In this case, fast growth is triggered by exploiting a non-product-related industry shift, combined with a well-planned acquisition program. These challengers move the acquired assets to a functionally specific direction and develop interdependent global management. They continuously improve product quality and expand product scope in order to differentiate themselves from competition and to expand the attainable market.

EI 67

KARI, R., **Fast Training of a High-Speed Voiceband Data Modem Receiver**. Helsinki 1990, 160 pp. ISBN 951-666-322-2.

Keywords: Modems, multipoint networks, adaptive equalization, carrier recovery, timing recovery.

Fast training of a high speed (up to 19.2 kbit/s) voiceband data modem receiver is studied theoretically and by computer simulations. Implementation and fast initialization of adaptive equalization, carrier recovery, and timing recovery are discussed. Various start-up equalization algorithms are reviewed and it is concluded that the cyclic start-up equalization algorithm based on DFT techniques with fractional tap spacing provides the most economic and efficient method for fast start-up equalization in high-speed voiceband data modems. It is also shown that the performance of the cyclic start-up equalization algorithm may be considerably improved by proper modifications. The modified algorithms improve the equalization of severely distorted channels and thus allow the use of a very short training sequence. Estimation of the carrier frequency offset and fast initialization of the carrier recovery system are discussed. Phase jitter tracking that is essential in voiceband data modems at rates above 9.6 kbit/s is also studied and a fast method for estimating the phase jitter value is presented. Finally, several algorithms for timing recovery are investigated. It is shown that the amount of timing jitter may be made almost independent of the channel characteristics by estimating the channel group delay at the band edges and modifying the timing recovery algorithms adaptively according to the group delay difference between the Nyquist frequencies. Efficient digital implementation of timing recovery is also studied and a modified square algorithm with reduced computational complexity is presented.

EI 68

**PYRHÖNEN, J., The High-Speed Induction Motor: Calculating the Effects of Solid-Rotor Material on Machine Characteristics.** Helsinki 1991, 84 pp. ISBN 951-666-332-X. UDC 621.313.33-947:621.3.043.3

**Keywords:** High speed induction motors, motor materials.

A method for the analysis of high-speed solid-rotor induction motors is presented. The analysis is based on a new combination of the three dimensional linear method and the transfer matrix method. Both saturation and finite length effects are taken into account. The active region of the solid rotor is divided into saturated and unsaturated parts. The time dependence is assumed to be sinusoidal and phasor quantities are used in the solution.

The method is applied to the calculation of smooth solid rotors manufactured of different materials. Six rotor materials are tested: three construction steels, pure iron, a cobalt-iron alloy and an aluminium alloy. The results obtained by the method agree fairly well with the measured quantities.

EI 69

**HÄGGMAN, S.-G., Microwave Line-of-Sight Channel Measurements, Channel Modelling, and Application of Channel Models to Digital Radio Performance Prediction.** Helsinki 1991, 52 pp. ISBN 951-666-336-2. UDC 621.371.3:621.391.883

**Keywords:** Propagation measurements, channel modelling, performance prediction.

Time and frequency domain measurements with pulse and sweep techniques, derivation of channel models from the results, and application of the models to performance prediction are studied.

The measuring systems and the methods leading to channel models are reviewed. Statistical models are obtained only from the frequency domain results. Single and two channel models for signal level fade and enhancement, amplitude dispersion, and single channel equivalent three-path models are derived. The latter single and two channel models are also available as parameter time history.

Three performance prediction approaches are tried. The first approach is based on Rummeler's channel model and on signature sets for various interference conditions. The second approach is based on the derived channel models. Several methods are used, also a new method where time is divided into mutually exclusive flat and dispersive fade time. The total outage can be summed, but normally flat fading outage can be neglected. The third approach is based on the time history model. Outage state is determined from signature sets, and cumulative outage is obtained from the stored time information. The method can be extended to calculation of the performance measures defined by CCIR.

Ma 53

GRANLUND, S., LINDQVIST, P. and VUORINEN, M., **Parameter Estimation for the Gummel-Poon Transistor Model**. Helsinki 1989, 19 pp. ISBN 951-666-282-X. UDC 621.382.33:519.233.2

Keywords: Bipolar transistor, parameter estimation, SPICE.

In his book of 1978 I. Getreu gives an account of the Gummel-Poon transistor model and describes a series of measurements, which provides data for the estimation of the model parameters. Exploiting and partly improving the graphical methods of Getreu, the authors suggest some algorithms for the practical evaluation of the model parameters in the PC environment. The algorithms are intended mainly for the CAD design of circuits in industrial applications and they provide estimates for the input parameters of circuit analyzing programs such as SPICE. The algorithms are implemented on IBM PC in the Turbo PASCAL language.

Ma 54

LINDQVIST, M., **Parameterized Reachability Trees for Predicate/Transition Nets**. Helsinki 1989, 120 pp. ISBN 951-666-285-4. UDC 519.681:519.688:681.3.08.

Keywords: Petri nets, predicate/transition nets, reachability analysis.

Elaboration of reachability analysis in the context of predicate/transition nets is studied. For this purpose, parameters are introduced into the markings of predicate/transition nets. The introduction into predicate/transition nets is started by presenting the basic Petri net classes, i.e. condition/event systems and place/transition systems. Predicate/transition nets are defined as condition/event systems augmented with annotations from first order logic. This increases significantly the modelling power of nets. Reachability analysis is introduced as a method of investigating the properties of systems modelled as nets. An approach to elaborate the analysis method in order to make it applicable also to larger systems is discussed in detail. The difficulties encountered in this approach, particularly with nets containing asymmetries, is taken as a motivation for looking for an alternative approach. This approach is based on introducing parameters into the marking of a net. These parameters represent any fixed individual values potentially appearing in the marking. The formalism to deal with parameterized markings is developed and the dynamics of predicate/transition nets are augmented to cope with the parameters. These are used to define parameterized reachability trees and an algorithm for generating them is presented. They are shown to be significantly smaller than ordinary reachability trees and to contain the same information. Examples of the generation of parameterized reachability trees are presented. Furthermore, the ways of exploiting them in the investigation of the properties of systems modelled as predicate/transition nets are studied. The possibilities of making parameterized reachability trees more general are also briefly discussed.

Ma 55

SAVOLAINEN, T., **Software Integration Technologies in Industrial Applications**. Helsinki 1990, 125 pp. ISBN 951-666-304-4. UDC 681.3.06:519.68:658.52.011.56

**Keywords:** CIM, CASE, software integration, SA/SD, LISP, CIMVIEW, CIMGLUE, STIF, software technologies.

Two CASE-tools for CIM are defined: "CIMVIEW" for high level, functional, top-down integration: company specific analysis and modelling, and "CIMGLUE" for low level, bottom-up integration: interfacing of existing applications. A method, "STIF", is defined for interface program design to reduce the need to change the interface during the normal evolution of the applications.

In "CIMVIEW" the user builds interactively a SA/SD data flow model of the functions of the company being examined. The functional decomposition of "bubbles" is internally converted into LISP representation. The contents of the data flow "arrows" are derived interactively from the actual customer files or scanned paper documents and converted into hierarchic LISP lists. The result is a LISP-model of the company functions under investigation. This model can be utilized by LISP-based tools for many purposes, including symbolic simulation, animation, metrics, data consistency and usage checks, automatic generation of the interface specifications and automatic generation of modified forms after one has simplified the data flows.

"CIMGLUE" is a general tool to build conversion programs between almost any software packages A and B. The conversion program is built interactively utilizing examples of package A's output and package B's input.

Both "CIMGLUE" and "CIMVIEW" tools are described generally for different types of implementations. A "CIMVIEW" -prototype has been implemented based on Common Lisp and Common Windows.

In the "STIF" (semantically transparent interfacing) method the variable definitions of the transferred items are isolated as much outside the interface as possible instead of using cross-references inside the interface. This is done by embedding some elements of the definition language of package A into the definition language of package B. Two example cases in which the method has been applied are described. The interfaces are in use in practical industrial applications.

Ma 56

WOODWARD, C., **Methods for Computer-Aided Design of Free-Form Objects**. Helsinki 1990, 60 pp. ISBN 951-666-313-3. UDC 681.3:658.512.2

**Keywords:** Computer-aided design, parametric curves and surfaces, B-splines, ray tracing.

A set of B-spline modelling and visualization methods has been developed to support interactive free-form shape design with the computer.

The swinging method is defined as a free-form generalization of the standard rotational sweep. More generally, the projection curve method facilitates surface skinning construction by plane curve interaction, having a strong resemblance to customary manual sketching. A variety of tools for local surface interaction is presented, including the B2-spline representation as an interface to smooth curve and surface interpolation.

A complete algorithm for ray tracing parametric surfaces is described. The adaptive zero-eye subdivision method is presented for efficient detection of ray intersections with parametric surfaces. The overall amount of ray tracing computation is reduced by utilizing coherence

properties with a novel method called shadow image buffers.

The methods described form the core of a computer-aided design system which is being used in different industrial applications.

Ma 57

JÄMSÄ-JOUNELA, S.-L., **Modern Approaches to Control of Mineral Processing**. Helsinki 1990, 33 pp. ISBN 951-666-316-8. UDC 681.5.03:681.5.015:681.5.017:622.73:622.765

**Keywords:** Grinding, flotation, modelling, multivariable control systems, expert control systems, inverse Nyquist array method.

Applications of modern control to mineral processing are studied in this thesis. The present introductory paper also comprises a survey of the dynamic, phenomenological models which have been developed and applied in the simulation of grinding and flotation processes.

Two industrial applications of the multivariable control theory for the grinding process control are presented. Process modelling, parameter estimation and control system design using the inverse Nyquist array method are described. Expert control system which consists of a supervisory program and two alternative control strategies, i.e. the multivariable control and the control system involving a combination of the conventional PI-controllers, is also described with an emphasis on practical performance and industrial implementation.

The dynamic, phenomenological model developed for the flotation process and the simulation results using sulphide ore data are presented. The process experiments for the determination of the model parameters using phosphate ore are also described, and the results of rougher flotation bank simulations are presented. The results of simulation studies using expert control and various self-tuning regulators for flotation are described and evaluated. Based on these simulation results the use of a flotation process simulator for industrial expert system development is outlined.

Ma 58

HÄMMÄINEN, H., **Form-Based Approach to Distributed Cooperative Work**. Helsinki 1991, 50 pp. ISBN 951-666-323-0. UDC 681.3

**Keywords:** User agent, form management, cooperative work, object-orientation.

This thesis develops an object-oriented form-based multiagent model to facilitate the rapid construction of integrated systems for distributed cooperative work. The model consists of autonomous asynchronous event-driven user agents managing private formbases and interacting with each other through form interchange. A high degree of abstraction is achieved by unifying the visual appearance, storage, processing and communication behavior of forms through a generalized form metaclass. As a central contribution, the thesis solves the integration of form classes among cooperating agents locally by means of a special inheritance scheme which allows flexible management of both the private and shared form classes. The conceptual model is implemented as a generic user agent called PAGES (Programmable Agents for Group Interaction Systems). PAGES is used to construct a system called CHAMADE (Change Management in Distributed Environment) which supports the integrated coordination of the formal and informal collaboration on order amendments between salesmen, designers and engineers along the supply chain in distributed manufacture of one-of-a-kind elevators. CHAMADE shows that the underlying object-oriented form abstraction

facilitates rapid construction of applications which are impossible, or at least impractical, to implement with more conventional tools. In addition, it shows that the throughput time of group tasks, e.g. change negotiations, can be significantly reduced when using these applications. The expected gross impact of faster group tasks is a shorter overall throughput time of elevators along the supply chain.



Me 93

LEHTOVAARA, A., **Kinetic Friction between Ski and Snow**. Helsinki 1989, 52 pp. ISBN 951-666-283-8. UDC 539.62:531.43:685.36:551.32/.33

Keywords: Friction, ski, snow, ice, mechanics.

A new model for kinetic friction between ski and snow was developed. Continuous sliding without dynamic effects was assumed. Both the dry and the wet friction components were taken into account in the model. Air humidity, snow free-water content and resistance caused by the macroscopic displacement of snow were not included in the study.

Experiments were carried out with plastic-based specimens sliding on ice. The friction coefficient was measured as a function of velocity and load at different temperatures. The experimental results are in reasonable agreement with calculated results. The partial differences in results are caused by contact parameters which are difficult to quantify and to keep constant during measurements.

The effect of the nominal contact pressure distribution and the contact length of the ski was studied numerically in detail in order to find out the effect of ski design parameters on the friction coefficient. It was found that the friction values are mostly determined by ski design parameters together with contact parameters, and hence one particular ski can operate optimally only in a small definite range of track and air conditions.

Me 94

UBONG, E.U., **Development of a Spark Assisted Direct Injection Multifuel Diesel Engine Especially for Alcohol Fuels**. Helsinki 1989, 80 pp. ISBN 951-666-288-9. UDC 621.43.045.33:621.43.038.5:662.754

Keywords: R&D, multifuel, multispark, variable spark duration, spark assisted diesel engine (SADE).

A multifuel, multispark assisted diesel engine (SADE) is developed. The combustion studies of the engine performance on ethanol fuel is presented. An investigation into the effect of multispark, variable spark duration on combustion variables and the engine performance is presented. This leads to the appropriate information concerning novel approaches to attaining a higher brake thermal efficiency and reducing exhaust emissions in future I.C. engines. This concept improves the operational limit, especially the lean limits of combustion of the developed engine. The results obtained showed that a SADE with a multispark discharge (MSD) ignitor and a variable spark duration has superior combustion characteristics to an equivalent conventional diesel engine in brake power, brake thermal efficiency, cylinder pressure, brake mean effective pressure, rate of cylinder pressure rise and cleaner exhaust. The engine developed a high brake thermal efficiency which makes its economy superior to the conventional SADE alcohol fuelled and moderately turbocharged diesel in this category. The engine does not smoke and the overall performance makes it available for all spark and compression ignition engine fuels including less volatile and self ignition resistant types of fuel.

Me 95

UBONG, E.U., **Influence of the Number of Sparks/cycle and Spark Duration on the Performance of a Spark Assisted Diesel Engine**. Helsinki 1990, 22 pp. ISBN 951-666-303-6. UDC 621.43.045.33:621.43.038.5:662.754

Keywords: Multispark, spark duration, spark assisted DI diesel engine.

A  $3^k$  factorial design ( $k = 3$ ) of experiment was used to investigate the influence of the number of sparks/cycle and variable spark duration (VSD) on the performance of a spark assisted diesel engine (SADE) in an open combustion chamber. A statistical treatment is introduced using the linear regression model to study the main and interactive effects. A correlation coefficient furnished the statistical relationship between numerous engine independent and response variables: maximum cylinder pressure and brake thermal efficiency, etc. Finally, F and t tests and a casewise plot of predicted and measured response variables were used to validate the model. The increase of the number of sparks/cycle and spark duration is found to extend the lean combustion limits, improve the rate of combustion and thereby improve the brake thermal efficiency.

Me 96

HANDROOS, H., **Methods for Combining a Theoretical and an Empirical Approach in Modelling Pressure and Flow Control Valves for CAE-Programs for Fluid Power Circuits**. Helsinki 1990, 52 pp. ISBN 951-666-315-X. UDC 621.646.3/4:681.5.015/.017

Keywords: Modelling, simulation, identification, CAE, fluid power, hydraulic, pressure control valve, flow control valve.

An analytical mathematical model for a fluid power valve uses equations based on physical laws. The parameters consist of physical coefficients, dimensions of the internal elements, spring constants etc. which are not provided by the component manufacturers. The valve has to be dismantled in order to determine their values. The model is accordant only with a particular type of valve construction and there are a large number of parameters. This is a major common problem in CAE-programs for fluid power circuits. In this study methods for solving this problem are presented by combining a theoretical and an empirical approach.

Analytical models for single-stage pressure and flow control valves are brought into forms which contain fewer parameters and whose values can be determined from measured characteristic curves. The least squares criterion is employed to identify the parameter values describing the steady-state of a valve. The steady-state characteristic curves that are the required data for this identification are quite often provided by the manufacturers. The parameters describing the dynamics of a valve are determined using a simple noncomputational method using dynamic characteristic curves that can be quite easily measured.

The importance of the identification accuracy of the different parameters of the single-stage pressure relief valve model is compared using a parameter sensitivity analysis method. A new comparison method called "relative mean value criterion" is used to compare the influences of variations of the different parameters to a nominal dynamic response.

Me 97

**TURUNEN, R., A Modelling of Unsteady Air Flow in the Resonance Charging System of High Speed Diesel Engines.** Helsinki 1990, 126 pp. ISBN 951-666-320-6. UDC 621.43.053.4:51.001.57

**Keywords:** High-speed diesel, turbocharging, resonance-charging, modelling.

A model for describing the unsteady flow in the high speed diesel engine resonance charging system and the formation of the air charge in the cylinder is developed. Attention has been paid to parameters like the charging pipe system geometry, the inlet valve discharge coefficient and timing, and the heat transfer in the cylinder during the intake period. The working of the model is ascertained by experiments with a test engine. The model can be used in the optimizing of the hape of the resonance pipe system.

Me 98

**UBONG, E.U., A Statistical Determination Method of Cylinder Combustion Conditions Using the Cyclic Variations of Some Measurable Engine Variables.** Helsinki 1991, 22 pp. ISBN 951-666-325-7. UDC 621.43.045.33:621.43-441.3:519.876.5

**Keywords:** Modelling, engine load determination, cyclic variation, diagnostic model, spark assisted DI diesel engine.

A statistical method of load determination and diagnosis of an abnormal condition of a multi-fuel spark-assisted diesel engine is proposed. The method employs combustion variables and engine exogenous parameters for its deterministic model. In the model, the mean value of the air-fuel ratio is considered a random variable; and the angle of the onset of ignition, the angle of the maximum cylinder pressure or the maximum cylinder pressure are considered stochastic processes associated with the random experiment. In this analysis, the engine parameters at normal operation are measured and stored in a statistical package. As the process is a continuous one, during the abnormal operation the values are compared with that at normal operation and the reason for the abnormality is discriminated. The linear regression model is used to establish the functional relationship between the response variable (air-fuel ratio) and independent variables (ignition timing, angle of the onset of ignition and the angle of the maximum cylinder pressure).

Me 99

**LAMPINEN, M., Calculation Methods for Determining the Pressure Loss of Two-Phase Pipe Flow and Ejectors in Pneumatic Conveying Systems.** Helsinki 1991, 53 pp. ISBN 951-666-335-4. UDC 533

**Keywords:** Two-phase flow, pneumatic conveying.

A review type of literature survey of the basic principles of pneumatic conveying transport is presented. The pressure drop for the pneumatic conveying pipe flow is studied. As a result of the analysis a new equation for calculating the pressure drop is derived. The new equation is based on determining two parameters, the velocity difference between gas and conveyed material and the falling velocity of material in the vertical pipe. The advantage of this equation is that no friction factors for solids are needed. As an example of the use of the pressure loss equation the pneumatic conveying of wood chips is considered. On the basis of the measurements the velocity difference parameters are determined. The numerical solution

of the pressure loss equation is presented in the form of curves, and the results are compared with the measurements.

Me 100

DALEY, C.G., **Ice Edge Contact - A Brittle Failure Process Model**. Helsinki 1991, 92 pp. ISBN 951-666-340-0. UDC 539.42:551.326:530.182

Keywords: Ice, ice pressure, ice loads, ice failure, brittle failure, chaos, piece-wise linear map, tent map, ice load statistics, failure process model.

The report concerns the ice-structure contact phenomenon. The causes of variability and randomness in ice impact loads are discussed. A simple cracking process is proposed, which sequentially removes flakes from the ice-structure contact zone. A macroscopic failure criterion, based on fracture mechanics and suitable for ice flaking is developed. The approach is based on the frictional sliding crack - wing crack model developed for ice by Ashby and Hallam. The flaking process is then simplified to one in which through-body cracks occur when the gross stresses on the failure plane reach critical values. The mechanics of such cracks are shown to lead to a hierarchy of cracks. Cracks of a given level run at the same angle, to the edges created by the next lower level of cracks. A finite number of levels of cracks occur, the number depending on the ice strength parameters. The report then employs chaos theory to analyze the behavior of the sequence of cracks in the numerical model. A simple set of analytical equations is used to model the ice contact process. The equations are piece-wise linear difference equations, which display chaotic behavior. The physical rationale for the chaotic behavior of the equations is the asymmetrical ice flaking. In the simplest cases, the resulting ice forces can be described with probability distributions derived from the analytical equations. The properties of the general tent map, which describes the forces for a single level of flaking, are shown to lead to a statistical distribution which is termed the folded distribution. The model's features are compared to experimental measurements and observations including: the presence of a narrow wavering zone of high intensity pressure, force time series, pressure-area relationships, piece size distributions, and statistical variations. Limitations and future directions are discussed.

Ph 163

**KAJAMAA, J., A New Way to Utilize Low Temperature Thermal Energy for the Production of Mechanical Energy.** Helsinki 1989, 56 pp. ISBN 951-666-280-3. UDC 621.48:669.017

**Keywords:** Low temperature thermal energy, shape memory metal.

The shape memory effect and its cyclic use for the production of mechanical energy utilizing low temperature thermal energy has been analyzed. By means of the applied atomistic model the creation of the relatively large force in the Ni-Ti lattice has been described. Also the way in which the energy is stored in the lattice has been quantitatively studied. Conditions for the reversibility of the cyclic process have been defined. Finally, the relationship of the applied model to some other phenomena has been examined.

Ph 164

**HARTIKAINEN, J., Fast Photothermal Techniques in Nondestructive Evaluation.** Helsinki 1989, 30 pp. ISBN 951-666-291-9. UDC 620.179.1

**Keywords:** Nondestructive evaluation, thermal imaging.

New fast thermal nondestructive techniques utilizing infrared cameras and scanners have been developed. These techniques are based on the scanned or pulsed heating of a sample and the time dependence of the surface temperature is affected by possible defects in the sample like cracks or coating adhesion defects. In the first measurement set-up the surface temperature was monitored with a simple and inexpensive infrared scanner and a hot air jet was used for heating. This resulted in heating pulse lengths that were on the order of 100 ms and so the technique is useful for low thermal diffusivity samples. Shorter heat pulses needed for the evaluation of plasma sprayed coatings have been obtained with a laser beam focused on a line. In the third measurement system the sample was heated with a laser beam focused on a point that was scanned over the sample surface with a deflection mirror. This technique allows the simultaneous recording of both the optical and thermal image of the sample which facilitates the interpretation of measurement results. In addition, two infrared camera based systems are presented where a flash lamp and a scanned laser beam were used as heat sources. In each case the time dependence of the surface temperature was analyzed numerically and the functionality of each measurement system was demonstrated with test samples. Typical measurement times varied from 45 seconds to a few minutes. The spatial resolution depends on the heating method and defect depth but the best achievable spatial resolution was typically 150  $\mu\text{m}$ .

Ph 165

**TUOMISAARI, M., Interaction of the Positron and the Positronium Atom with Insulating Fluids and Solids.** Helsinki 1990, 33 pp. ISBN 951-666-300-1. UDC 539.124.6:538.95

**Keywords:** Positrons and positronium.

Experimental positron lifetime results in argon and xenon indicate and theoretical calculations confirm the clustering of atoms around the positron and the bubble formation around the positronium atom in a certain temperature and density range. The results may be



generalized to practically all gases at temperatures not too far from the critical temperature. Agreement between experiment and density functional theory is good for clusters and satisfactory for bubbles. Introducing a model that includes also the effect of metastable density inhomogeneities improves the qualitative agreement with the experimental positronium lifetime results, but it does not remove the problem of estimating the positronium-atom interaction. The peculiarities in the xenon results as compared to the lighter rare gases are partly attributed to the weak moderation efficiency of xenon. Positronium time-of-flight measurements on solid rare gases and several alkali halides indicate that energetically narrow positronium distributions are formed in the interior of wide band gap insulators. The energy distributions are well described by the Ore formation model. The energetic positronium formed at the positron implant depth diffuses to the surface, losing energy in the process. An analysis of the data using hot-carrier diffusion model simulations yields an estimate of the strength of the positronium-phonon coupling. The coupling is found to be energy-dependent.

Ph 166

HUTTUNEN, P.A., **Positron Interactions on Solid Surfaces and at Bilayered Structures**. Helsinki 1990, 34 pp. ISBN 951-666-305-2. UDC 539.124.6, 529.23

Keywords: Positron annihilation, surfaces, layered structures, epitaxy, positron transport, defects.

A monoenergetic positron beam, operated under ultra-high-vacuum, has been utilized to examine the interaction mechanisms of a positron at the vacuum-solid and the solid-solid interfaces. The positron surface processes and the underlying mechanisms are studied by monitoring their temperature and energy dependencies. Different fundamental aspects influencing positron motion at an interface of two materials are discussed. Furthermore, positron energy-loss mechanisms at the final stages of thermalization and thermal positron motion in the solids are studied. The positron diffusion is applied to extract defect profiles in heteroepitaxial structures.

Ph 167

SALOHEIMO, K., **Model Studies on Spectral Induced Polarization**. Helsinki 1990, 114 pp. ISBN 951-666-306-0. UDC 550.837.312:51.001.57

Keywords: Spectral induced polarization, theoretical model.

In this thesis, the theory of spectral induced polarization is studied in terms of a microscopic model to account for the complicated surface geometry of the polarizing ore. An ore grain is described by a set of galvanically connected spherical granules, immersed in a homogeneous electrolytic medium. The IP response is calculated for one-, two-, and three-dimensional arrangements of the spheres. The results indicate that the total surface area of the ore grain is an important geometrical parameter of the IP response, in addition to the grain dimensions.

A simple IP experiment was carried out with a circulating slurry made of saline water and pyrite grains sieved to a definite grain size. The width of the measured spectra is interpreted to arise from a folded surface geometry of the grains.

With actual IP measurements, a distribution of grain sizes is involved in the polarization response. The distribution function is obtained from a measured spectrum as a solution of Fredholm's integral equation of the first kind, with the response of a single grain size as a kernel function. This approach is applied to the results of the slurry experiments, and real IP



data obtained from two magnetite deposits, including laboratory measurements of core samples and field spectra. The results exhibit a good correlation with visual observations made from the core samples.

Ph 168

AARNIO, P., **Computational Methods for Hadronic Cascades, Gamma Spectroscopy and Activation Detectors**. Helsinki 1990, 37 pp. ISBN 951-666-310-9. UDC 539.1.074:539.12

Keywords: Monte Carlo simulation, hadronic cascades, calorimetry, DELPHI, gamma spectroscopy, activation detectors.

A review of general properties of high energy hadronic and electromagnetic cascades is given. The physical processes affecting the cascade development are briefly described and the models used in the Monte Carlo transport code FLUKA reviewed. The problem of cascade transport is formulated and its solution methods are briefly discussed. Use of activation detectors in measurement of high and low energy hadron fluence spectra is presented. Methods for optimization of multicomponent activation detectors are described. Such detectors are measured using advanced gammaspectroscopic techniques which have been incorporated in a general purpose software package MicroSAMPO.

Ph 169

SERIMAA, R., **X-Ray Scattering Studies on Weakly Ordered Materials**. Helsinki 1990, 24 pp. ISBN 951-666-312-5. UDC 539.26

Keywords: X-ray scattering, weakly ordered materials, cellulose, platinum uridine green, aluminium oxide.

The structure of weakly ordered materials was studied by means of wide- and small-angle x-ray scattering (WAXS, SAXS). Model calculations were used as a tool to interpret experimental results. The work includes a study of the role of multiple scattering in data analysis of WAXS experiments. The methods were applied to studies of the structures of cellulose, platinum uridine green, and  $-AL_2O_3$ .

The structures of microcrystalline and amorphized cellulose were studied by means of WAXS experiments. The intensity curve of microcrystalline cellulose could be interpreted in terms of a model of randomly distributed crystallites. According to the calculation, the diffuse background of the experimental intensity curve can be caused primarily by the small crystal size and only secondarily by scattering from an amorphous phase. For amorphized cellulose model scattering ensembles consisting of tiny relatively well ordered regions formed by parallel chains were found to give a good agreement with experimental results. These units can be remnants of the former crystalline structure.

The structure of platinum uridine green was characterised by means of the radial atomic distribution function determined by WAXS and the size of dissolved molecules determined by SAXS. It is proposed that the basic structure of amorphous platinum uridine green is tetrameric.

According to results of SAXS experiments, there are considerable differences in the porous structures of  $-AL_2O_3$  samples. The grain sizes were found to correlate with the crystal size only occasionally. Interparticle interference effects were found to play an important role in model calculations.

Ph 170

LESKELÄ, M. and NYKÄNEN, E. (eds), **5th International Workshop on Electroluminescence**. Helsinki 1990, 306 + IX pp. ISBN 951-666-317-6. UDC 535.376:061.3, 539.23:538.975

This volume contains the proceedings of the 5th International Workshop on Electroluminescence held June 11-13, 1990, in Espoo, Finland.

Ph 171

VOLOTINEN, T., **Influence of the Standard Single Mode Fibre Bends on Cable Properties Investigated by the  $\alpha_{11}$ ,  $(\lambda)$  method**. Helsinki 1990, 184 pp. ISBN 951-666-318-4

**Keywords:** Single mode fibres (fibers), optical fibre cables, bend attenuation (loss), micro bending, macro bending, bend attenuation of the LP11 mode, whispering gallery modes.

A new method has been developed to investigate single mode fibre bends in optical fibre cables. The method is based on the measurement of the LP11 mode bend attenuation coefficient as a function of wavelength, and can be applied to from 2 m to 20 km long test samples. Both micro bend and macro bend attenuations can be investigated, and the equivalent bend diameter of a fibre in a cable and the corresponding attenuation increase of the LP01 mode can be estimated by the method. The individual 2 m macro bend test of the fibre, from which the bend sensitivity and the structural profile parameters of the fibre can also be estimated, is used as a bend diameter scale in the cable investigations.

The method and bend attenuations of the current standard single mode fibres of matched and depressed cladding type were studied by applying the step index fibre theory. The bend sensitivities were measured by applying the new method. A new equation to approximate the fibre's critical bend diameters/wavelengths to additional attenuation increases and decreases caused by whispering gallery modes has also been derived. The fibre bends and the causes of the attenuation increases in several loose tube cable designs have been investigated. The equivalent bend diameter of a fibre in a cable can be measured on 30 mm - 1 m bend diameters, even without any attenuation increases of the LP01 mode. The cables have been investigated in short sections in modified 30 m temperature cycling and in 25 m straight sample tensile performance tests. The results have been compared with the results from standard cable tests. The method was proved to be very advantageous compared with the standard cable test methods. Development time and costs of new cable designs can be greatly decreased by testing cables in short sections.

Ph 172

VOIPIO, J., **Role of Bicarbonate in the Actions of Gamma-Aminobutyric Acid (GABA) on Membrane Conductances, Currents and pH Regulation in Excitable Cells**. Helsinki 1990, 66 pp. ISBN 951-666-321-4. UDC 577.352

**Keywords:** Gamma-aminobutyric acid, GABA, synaptic inhibition, intracellular pH, surface pH, intracellular chloride, bicarbonate permeability, ion-selective microelectrodes, electrometer amplifier, linear cable theory.

Ion-selective microelectrodes and a two- or three-microelectrode voltage or current clamp were used to examine the effects of the inhibitory neuro-transmitter gamma-aminobutyric acid (GABA) on intracellular pH ( $\text{pH}_i$ ), extracellular surface pH ( $\text{pH}_s$ ), intracellular chloride activity ( $a_{\text{Cl}^-}$ ) as well as on membrane potential, current and conductance in crayfish muscle

fibres and the stretch-receptor neurone (SRN). In the muscle, a near-saturating concentration of GABA induced the following channel-mediated,  $\text{HCO}_3^-$ -dependent effects: a depolarizing inward current, a rise in  $a_{\text{Cl}^-}$  and  $\text{pH}_i$  and a fall in  $\text{pH}_o$ . Substitution of 30 mmol/l of  $\text{Cl}^-$  by  $\text{HCO}_3^-$  brought about a  $\text{pH}_i$ -dependent positive deviation of the reversal potential of the GABA-induced current ( $E_{\text{GABA}}$ ) from the equilibrium potential of  $\text{Cl}^-$  ( $E_{\text{Cl}^-}$ ). Experiments on the SRN gave very similar results. Measurements of  $E_{\text{GABA}}$  yielded a value of about 0.3 for the relative permeability of  $\text{HCO}_3^-$  vs.  $\text{Cl}^-$  in the GABA-channel. Experiments with carboxylate anions indicated that the effective diameter of the GABA-gated channel in the muscle fibre is about 0.5 nm which is close to the value measured in mammalian  $\text{GABA}_A$ -channels. The present results show that the widely accepted equivalence of  $E_{\text{Cl}^-}$  and  $E_{\text{GABA}}$  is not valid under physiological conditions, and that there is a bidirectional link between actions of GABA and regulation of pH. Application of linear cable theory as well as thermal design of electrometer amplifiers are also discussed.

Ph 173

LAHTINEN, J. et al., **Design of a Combined UHV-Atmospheric Pressure Apparatus for Catalytic Surface Studies**. Helsinki 1991, 16 pp. ISBN 951-666-324-9. UDC 539.211:541.128:533.59

Keywords: UHV, surfaces, reaction cell, heterogeneous catalysis.

We report on the construction of a combined ultrahigh-vacuum (UHV) atmospheric pressure apparatus for versatile studies related to heterogeneous catalysis. In the system X-ray photoemission spectroscopy, Auger electron spectroscopy, low energy electron diffraction and thermal desorption spectroscopy can be used. An effusion cell is used for metal evaporation. The atmospheric pressure cell is located inside the UHV chamber. The advantages of this system are a relatively inexpensive construction and the possibility to perform reaction experiments at atmospheric pressures in situ. Several surface sensitive spectroscopies have been made available in a small volume, because of the focal points for different equipment are located on a circle inside the main chamber. The characteristics of this equipment are discussed together with some typical data.

Ph 174

AROLA, E., **The Relativistic KKR-CPA Method: A Study of Electronic Structures of  $\text{Cu}_{75}\text{Au}_{25}$ ,  $\text{Au}_{70}\text{Pd}_{30}$ , and  $\text{Cu}_{75}\text{Pt}_{25}$  Disordered Alloys**. Helsinki 1991, 138 pp. ISBN 951-666-328-1. UDC 539.2:530.145:53.082.52

Keywords: Korringa-Kohn-Rostoker coherent-potential-approximation, substitutionally disordered alloy, angle-resolved photoemission.

The first principles fully relativistic Korringa-Kohn-Rostoker coherent-potential-approximation (R-KKR-CPA) approach has been developed and implemented for the purpose of discussing the electronic structure of substitutionally disordered random binary alloys containing heavy elements. Expressions for the total and site-decomposed densities of states, and Bloch spectral density functions are discussed within the framework of the Lloyd-type as well as the Green's function formulations. An efficient algorithm for solving the R-KKR-CPA equation has been developed which yields rapidly convergent solutions for wide range of parameters. The structure of the relativistic CPA t-matrix and related quantities is delineated by using the properties of the cubic double point symmetry group. As applications of the

theory, extensive R-KKR-CPA computations on three heavy metal alloys are presented and discussed. These are,  $\text{Cu}_{75}\text{Au}_{25}$ ,  $\text{Au}_{70}\text{Pd}_{30}$ , and  $\text{Cu}_{75}\text{Pt}_{25}$ ; the latter two binary alloy systems possess important catalytic properties. In each case, concurrent angle-resolved photoemission (ARPES) experiments from low index faces of the alloy single crystals were carried out for several UV radiations. The theoretical complex energy bands, densities of states, and Bloch spectral densities are used to interpret our ARPES measurements. In each of the three cases investigated in detail, a good overall accord is found between the R-KKR-CPA predictions and the measured shifts and smearings of the various bulk bands in k-point-by-k-point detail.

Ph 175

SAARINEN, K., **Point Defect Structures in Gallium Arsenide Studied by Positron Spectroscopies**. Helsinki 1991, 36 pp. ISBN 951-666-330-3. UDC 539.124:620.186

Keywords: Point defects, vacancies, semiconductors, positron annihilation.

Positron spectroscopies have been used to examine the point defect structure of gallium arsenide. Experiments have been performed to investigate the properties of native defects in as-grown GaAs. Furthermore, the defect production during electron irradiation, hydrogen implantation and plastic deformation of GaAs have been studied by positron techniques. New information is obtained especially on the properties of vacancy defects. In as-grown GaAs, the ionization levels of arsenic vacancies are determined. In semi-insulating GaAs, the metastable state of the EL2 defect is shown to contain a monovacancy. The introduction of vacancies and antisite defects to the gallium sublattice is observed in electron irradiation of GaAs. In deformed GaAs, the simultaneous formation of vacancies, antisites and vacancy complexes is detected. Finally, the depth distributions of vacancies are determined after hydrogen implantation in semi-insulating GaAs, and the recovery of the implantation damage during isochronal annealing is investigated.

Ph 176

MÄKINEN, J., **Positron Dynamics in Solids**. Helsinki 1991, 52 pp. ISBN 951-666-334-6. UDC 539.124:620.186

Keywords: Positron annihilation, positron beams, diffusion, semiconductors, surfaces.

The low-energy positron beam and positron lifetime spectroscopies have been used to investigate positron-solid interactions. The topics include positron diffusion in solids, interaction with solid surfaces and positron annihilation in semiconductors. The results presented in this thesis form a comprehensive study of positron diffusion in metals. Coupling of positrons to acoustic phonons has long been recognized as the dominant scattering mechanism. This is now verified experimentally in a wide temperature region from 20 K to the onset of positron trapping at thermal vacancies. Positron motion in electric field in Si was investigated in a surface barrier diode. Below 300 K, the lattice scattering mechanism limiting positron motion is due to acoustic phonons. Positron emission and positronium formation were studied at clean metal surfaces. The discovery of a rapid decrease of both yields at low temperatures at negative-work-function surfaces is consistent with simple wave-mechanical reflection of the positron from the surface barrier. Positron trapping at negatively charged centers in electron-irradiated silicon was examined using the lifetime technique. A very large trapping cross section and a strong temperature dependence of the trapping rate were discovered. This is

ascribed to positron trapping at weakly-bound Rydberg states in the long-range Coulomb potential. Also, the effect of the breathing-mode volume relaxation of the phosphorus-vacancy pair on positron lifetime was demonstrated.

Ph 177

SPRING, E. et al., **Drag Analysis of Athletes Using Wind Tunnel Tests**. Helsinki 1991, 13 pp. ISBN 951-666-341-9. UDC 533.6.07

Keywords: Drag, wind tunnel, athlete.

A low speed wind tunnel was used to test different clothing materials used in sports. The drag force of the wind on a limb simulating test cylinder was measured. The cylinder could be covered with different clothing materials of interest. In addition, the drag on the cylinder was measured with leg spoilers of different shapes attached to it. The results show that the surface structure of the athlete's cloth influences remarkably his/her drag, and e.g. a seam in the textile has been found to influence the drag. Seams increase drag depending on their position. Since the drag is strongly dependent on the Reynold's number of the test object, the choice of proper clothing is important to minimizing the athlete's drag i.e. the clothing of an athlete should be chosen according to the speed of the athlete during the sport performance. The importance of leg spoilers is well-known among downhill speed skiers. Our measurements show that great attention should be paid to the choice of leg spoilers. The drag may vary by more than 15 % depending on the shape and size of spoilers on the range of Re-numbers from  $0.2 \times 10^5$  to  $1.5 \times 10^5$ .

Ph 178

PUNKKA, E., **Electrical Characterization of Conducting Polymers and Polymeric Semiconductor Devices**. Helsinki 1991, 30 pp. ISBN 951-666-342-7. UDC 678.7:537.31:621.382

Keywords: Conducting polymers, Langmuir-Blodgett films, semiconductor devices.

Electrically conducting polymers have been characterized by transport measurements and by utilizing polymeric semiconductor devices. The temperature and electric-field dependences of the conductivity indicate that the transport mechanism changes from variable-range hopping between localized states in undoped poly(3-alkylthiophenes) to charging-energy-limited tunneling between highly conducting islands in the doped polymer. The experiments yield detailed quantitative information on the electrical conduction processes and the structural homogeneity of the poly(3-alkylthiophenes) processed to free-standing films, polymer blends, spin-cast films, and Langmuir-Blodgett films. Field-effect transistors, Schottky diodes, and metal-insulator-semiconductor structures have also been fabricated using thin films of poly(3-alkylthiophene) and polypyrrole as active semiconductive components. Important parameters, such as the charge carrier mobility, dopant concentration, and the height and width of a rectifying barrier are extracted from the device characteristics. The device configurations are further utilized in the dopant profiling of novel molecular heterostructures.

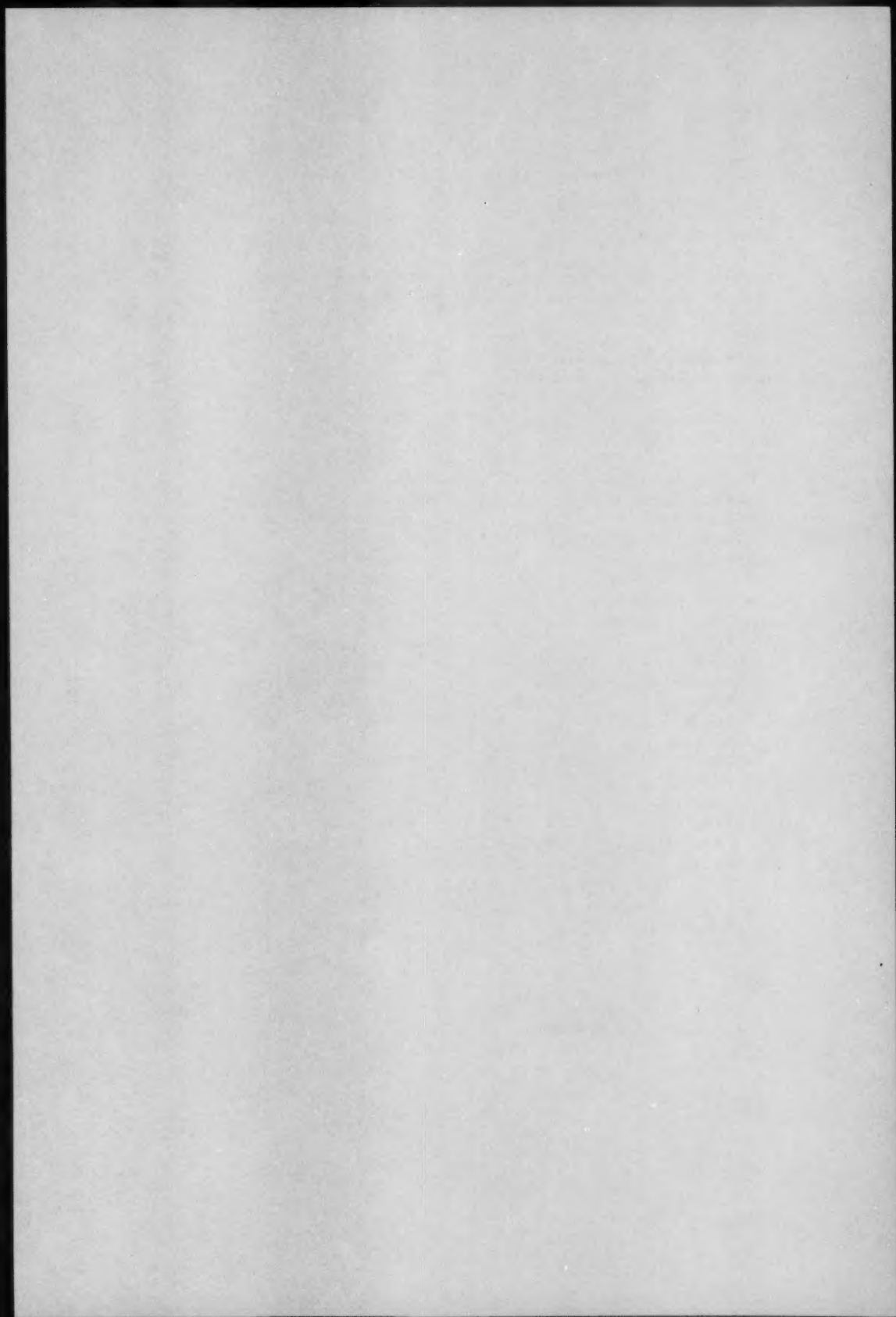


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